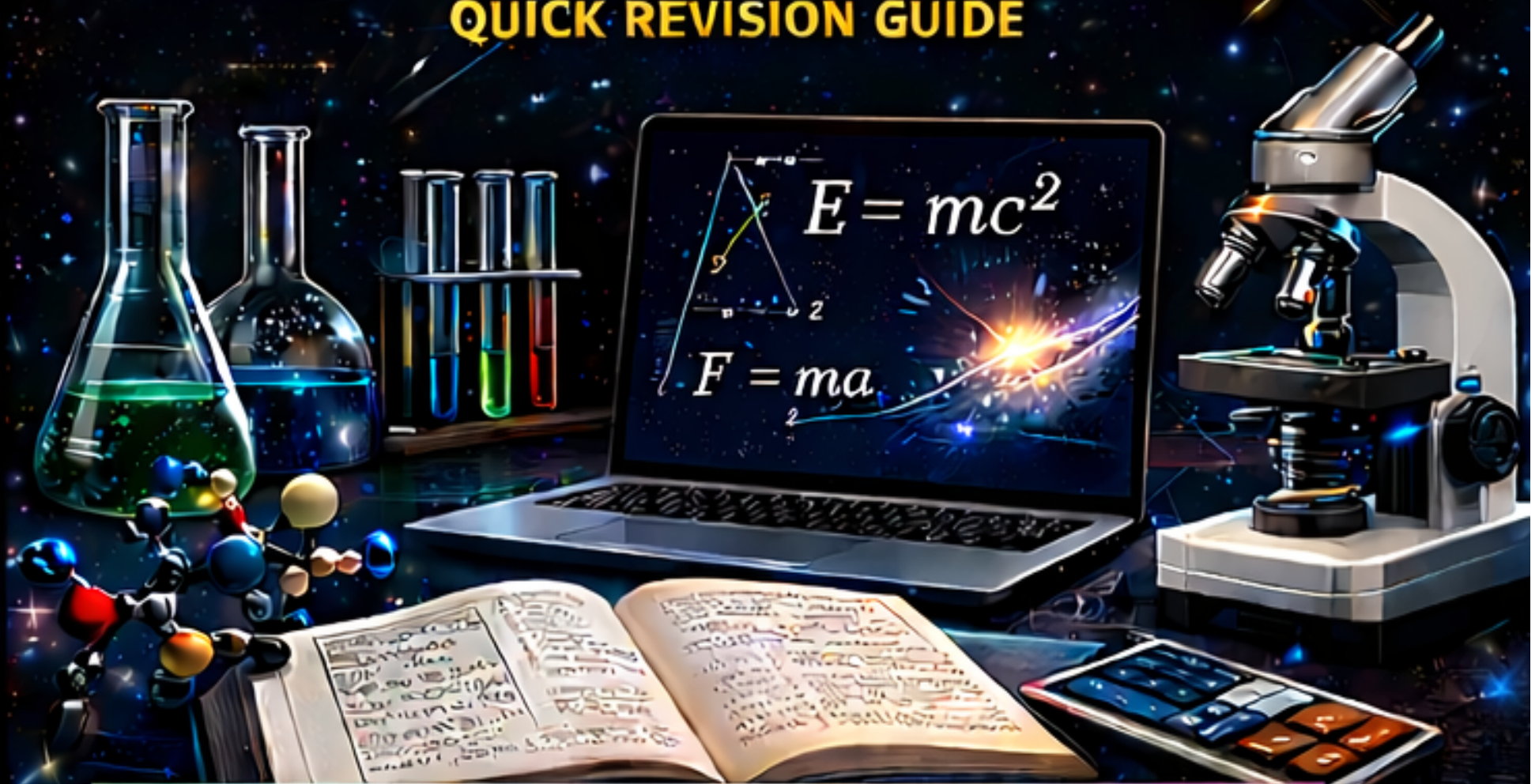


SCIENCE • MATHEMATICS • KNOWLEDGE • SUCCESS

THE ULTIMATE SPEED BOOK

COMPLETE FORMULAE, CONCEPTS, MNEMONICS &
QUICK REVISION GUIDE



BIOLOGY



CHEMISTRY



PHYSICS



MATHEMATICS

For SHS, WASSCE & Competitive Exams

JUSTICE OSEI OFOSU

PREFACE

The Ultimate Speed Book was developed out of a clear and pressing need—to bridge the gap between knowledge acquisition and effective performance in high-stakes examinations such as WASSCE and the National Science and Mathematics Quiz (NSMQ). This book contains carefully selected formulas, key concepts, and concise write-ups designed to support quick understanding and effective revision.

Over time, it has become evident that many students possess the content but lack the structured approach, clarity, and speed required to apply that knowledge under pressure. This book seeks to address that gap.

The material presented here is not a random compilation of notes, but a carefully curated and strategically organized resource. Each concept has been simplified without losing its academic depth, allowing learners to grasp, retain, and recall information efficiently. The emphasis throughout the book is on precision, clarity, and application—three pillars that define academic excellence.

TO EVERY READER, I SAY THIS:

“EXCELLENCE IS NOT ACCIDENTAL. IT IS BUILT THROUGH CONSISTENCY, FOCUS, AND DELIBERATE PRACTICE. LET THIS BOOK GUIDE YOU—BUT LET YOUR DETERMINATION CARRY YOU TO THE TOP.”

DEDICATION

I dedicate this book first and foremost to God Almighty, the source of wisdom, grace, strength, and understanding, have made this journey possible. Every insight, every idea, and every completed page is a reflection of His guidance and favor.

I also dedicate this book to students who strive relentlessly for excellence—those who refuse to be limited by circumstances, who choose discipline over distraction, and who are committed to achieving their highest academic potential. This book is for those who study when others rest, who question deeply, and who prepare not just to pass, but to excel. **Thomas Edison, the inventor of electric light bulb once said, “Genius is one percent inspiration and ninety-nine percent perspiration.”**

To every learner who believes that greatness is possible through hard work and consistency, this work stands as a reminder that your efforts are not in vain. Keep pushing, keep learning, and never settle for less than your best.

ACKNOWLEDGEMENT

I wish to express my profound gratitude to **Dr. Isaac Aninakwah, my uncle, a Geographer and lecturer whose work spans Geography and Environmental Studies, with a strong focus on teaching, research, and a lecturer at Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development (AAMUSTED) and St. Monica's College of Education.** He has been a strong source of academic inspiration. His guidance, discipline, and commitment to excellence have greatly influenced my approach to learning and my pursuit of academic success. Whose intellectual guidance, mentorship, and unwavering commitment to academic excellence have played a significant role in shaping this work. His depth of knowledge and passion for teaching continue to inspire rigorous thinking and scholarly discipline.

I am immensely grateful to **Enoch Aninakwah (MPhil) – A Physical Geographer with a specialty in Geomorphology, Oceanography, RS/GIS and Pedology skills and expertise, University of Ghana (UG).** For his invaluable support, constructive insights, and continuous encouragement throughout the development of this book. His contributions have been instrumental in refining both the structure and quality of this work.

My sincere appreciation also goes to **all students, colleagues, and mentors** whose curiosity, engagement, and pursuit of knowledge have influenced the creation of this Speed Book. Their questions and academic challenges have helped shape the clarity and direction of the content presented here.

Finally, I acknowledge all individuals who, in diverse ways, contributed to this journey—whether through support, encouragement, or inspiration. This book stands as a collective product of shared knowledge, experience, and dedication to academic excellence.

Mathematics

Quadratic Equation

$$4x^2 - 6x + 3 = 0$$

$$a = 4 \quad b = 6 \quad c = 3$$

$$x = \frac{b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x = \frac{6 \pm \sqrt{6^2 - 4(4)(3)}}{2(4)}$$

$$x = \frac{6 \pm \sqrt{36 - 48}}{8}$$

$$x = \frac{6 \pm \sqrt{-12}}{8}$$

$$x = \frac{6 \pm \sqrt{-4 \times 3}}{8}$$

$$x = \frac{6 \pm 2\sqrt{3}i}{8}$$

$$x = \frac{6 - 2\sqrt{3}i}{8} \quad \text{or} \quad x = \frac{6 + 2\sqrt{3}i}{8}$$

$$x = \frac{3 - \sqrt{3}i}{4} \quad \text{or} \quad x = \frac{3 + \sqrt{3}i}{4}$$

SETS (My Writeups)

$$n(A \cup B) = n(A) + n(B) - n(A \cap B)$$

$$n(\text{Only } A) = n(A) - n(A \cap B)$$

$$n(A \cup B \cup C) = \sum n(A) - \sum n(A \cap B) + n(A \cap B \cap C)$$

$$\text{Power set} = 2^n$$

$$\text{Proper subsets} = 2^n - 1$$

$$\text{Non-empty subsets} = 2^n - 2$$

$$\text{Power set } n(A) = m = 2^{(2^m)}$$

$$A / B = A \cap B'$$

$$(A \cup B)' = A' \cap B'$$

$$(A \cap B)' = A' \cup B'$$

$$A \cup (A \cap B) = A$$

$$A \cap (A \cup B) = A$$

$$A \cap (B \cup C) = (A \cap B) \cup (A \cap C)$$

$$(A')' = A$$

Collection of all points satisfying a condition (Locus)

$$\emptyset \subseteq A$$

$$A \cup A' = U$$

$$A \cap A' = \emptyset$$

$$A \cup U = U$$

$$A \cap U = A$$

$$A \cap \emptyset = \emptyset$$

SURDS

$$1 / (\sqrt{a} \pm \sqrt{b}) = (\sqrt{a} \mp \sqrt{b}) / (a - b)$$

$$1 / (\sqrt{n} + \sqrt{(n-1)}) = \sqrt{n} - \sqrt{(n-1)}$$

Comparing Surds – Square the surds

$$3\sqrt{5} \text{ vs } 5\sqrt{2}$$

$$(\sqrt{a/b})^2 = a^2/b$$

Comparing $\sqrt{a} + \sqrt{b}$ and $\sqrt{c} + \sqrt{d}$

$$a + b = c + d$$

$$ab = cd$$

(the pair with the larger number is the greater)

$$1 / (\sqrt[3]{a} - \sqrt[3]{b}) = (\sqrt[3]{a^2} + \sqrt[3]{ab} + \sqrt[3]{b^2}) / (a - b)$$

$$1 / (\sqrt[3]{a} + \sqrt[3]{b}) = (\sqrt[3]{a^2} - \sqrt[3]{ab} + \sqrt[3]{b^2}) / (a + b)$$

$$(\sqrt{a} + \sqrt{b})^2 = a + b + 2\sqrt{ab}$$

$$(\sqrt{a} - \sqrt{b})^2 = a + b - 2\sqrt{ab}$$

$$(\sqrt{a} + \sqrt{b})(\sqrt{a} - \sqrt{b}) = a - b$$

$$\sqrt{a^2b} = a\sqrt{b}$$

$$\sqrt{a} / \sqrt{b} = \sqrt{a/b}$$

Squaring Numbers Ending with 5 (n5)

$$75^2 = 7 \times 8 \mid 25 = 5625$$

$$n5^2 = [n \times (n + 1)] \mid 25$$

$$25^2 = 2 \times 3 \mid 25 = 625$$

$$105^2 = 11025$$

$$95^2 = 9025$$

Base 100 (90–110)

$$(100 \pm d)^2$$

$$d = \text{deviation}$$

$$96^2 = (100 - 4)^2 = 9216$$

$$97^2 = (100 - 3)^2 = 9409$$

$$102^2 = (100 + 2)^2 = 10404$$

Base 50 (40–60)

$$(25 \pm c)^2$$

c = deviation

$$48^2 \rightarrow c = -2$$

$$\begin{aligned} &= (25 - 2)^2 \\ &= 2304 \end{aligned}$$

$$\begin{aligned} 56^2 &= 25 + 6 \mid 36 \\ &= 3136 \end{aligned}$$

Duplex Identity

$$(a^2 + 2ab + b^2)$$

Example:
 $(32)^2$

$$a = 3, b = 2$$

$$a^2 = 9$$

$$2ab = 12$$

$$b^2 = 4$$

$$\rightarrow 1024$$

Adjacent Squares

Up rule:

$$n^2 = (n - 1)^2 + (2n - 1)$$

Down rule:

$$(n - 1)^2 = n^2 - (2n - 1)$$

Examples:

$$31^2 = 30^2 + 61 = 961$$

$$41^2 = 40^2 + 81 = 1681$$

$$29^2 = 30^2 - 59 = 841$$

Multiplication Tricks

By 5:

$$100 \times 5 = (100 \times 10) / 2 = 500$$

By 9:

$$90 \times 9 = 90 \times 10 - 90 = 810$$

Binary Operations

- $a * b = a + b$ $e = 0$ $a^{-1} = -a$
- $a * b = ab$ $e = 1$ $a^{-1} = 1/a$
- $a * b = a + b + ab$ $e = 0$ $a^{-1} = -a/(1 + a)$

FUNCTIONS & RELATIONS

Functions

1-1 (Injective):

$$f(f^{-1}(y)) = y$$

$$f(x) = mx + c$$

$$f^{-1}(x) = (x - c) / m$$

$$f(x) = x^2 (x \geq 0) \rightarrow f^{-1}(x) = \sqrt{x}$$

$$f(x) = 1/x \text{ (same)}$$

$$f(x) = a^x \rightarrow f^{-1}(x) = \log_a x$$

$$f(x) = e^x \rightarrow \ln x$$

Types of Relations

Reflexive

Symmetric

Transitive

Anti-symmetric

Equivalence

SPECIAL VALUES & TABLES

Cosine Values (Decimal)

$$10^\circ \rightarrow 0.985$$

$$20^\circ \rightarrow 0.940$$

$$30^\circ \rightarrow 0.866$$

$$40^\circ \rightarrow 0.766$$

$$50^\circ \rightarrow 0.643$$

$$60^\circ \rightarrow 0.5$$

$$70^\circ \rightarrow 0.342$$

$$80^\circ \rightarrow 0.174$$

$$90^\circ \rightarrow 0$$

Sine Values (Decimal)

$$10^\circ \rightarrow 0.174$$

$$20^\circ \rightarrow 0.342$$

Special Numbers

$$\pi = 3.1459$$

$$e = 2.71828$$

$$\phi = 1.61803$$

$$i = \sqrt{-1}$$

$$\varphi = (1 + \sqrt{5}) / 2$$

Square Roots (Approx.)

$$\sqrt{2} = 1.414$$

$$\sqrt{3} = 1.732$$

$$\sqrt{5} = 2.236$$

$$\sqrt{6} = 2.449$$

$$\sqrt{8} = 2.828$$

$$\sqrt{10} = 3.162$$

$$\sqrt{11} = 3.317$$

$$\sqrt{12} = 3.464$$

$$\sqrt{13} = 3.606$$

$$\sqrt{14} = 3.742$$

$$\sqrt{15} = 3.873$$

$$\sqrt{17} = 4.123$$

$$\sqrt{18} = 4.243$$

ALGEBRA, LOGS & IDENTITIES

Logarithm Laws

$$\log_b(xy) = \log_b(x) + \log_b(y)$$

$$\log_b(x/y) = \log_b(x) - \log_b(y)$$

$$\log_b(x^n) = n \log_b(x)$$

$$\log_b(b) = 1$$

$$\log_b(1) = 0$$

Change of Base

$$\log_b(x) = \log_k(x) / \log_k(b)$$

Quadratic Formula

$$ax^2 + bx + c = 0$$

$$x = (-b \pm \sqrt{b^2 - 4ac}) / 2a$$

Algebraic Identities

$$(a + b)^2 = a^2 + 2ab + b^2$$

$$(a - b)^2 = a^2 - 2ab + b^2$$

$$a^2 - b^2 = (a + b)(a - b)$$

$$(a + b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$$

$$(a - b)^3 = a^3 - 3a^2b + 3ab^2 - b^3$$

$$a^3 + b^3 = (a + b)(a^2 - ab + b^2)$$

$$a^3 - b^3 = (a - b)(a^2 + ab + b^2)$$

$$(a + b + c)^2 = a^2 + b^2 + c^2 + 2ab + 2bc + 2ac$$

Indices (Laws of Powers)

$$a^m \times a^n = a^{m+n}$$

$$a^m \div a^n = a^{m-n}$$

$$(a^m)^n = a^{mn}$$

$$(ab)^n = a^n b^n$$

$$(a/b)^n = a^n / b^n$$

$$a^0 = 1 \ (a \neq 0)$$

$$a^{-n} = 1 / a^n$$

$$a^{1/n} = \text{nth root of } a$$

GEOMETRY + SOLIDS

Plane Geometry

Rectangle:

$$A = L \times W$$

$$P = 2(L + W)$$

Square:

$$A = l^2$$

$$P = 4l$$

Triangle:

$$A = 1/2 bh$$

Heron's formula:

$$A = \sqrt{s(s-a)(s-b)(s-c)}$$

$$s = (a + b + c)/2$$

Circle:

$$A = \pi r^2$$

$$C = 2\pi r$$

Area Formulas

Trapezium:

$$A = 1/2 (a + b)h$$

Parallelogram:

$$A = bh \text{ or } ab \sin\theta$$

Ellipse:

$$A = \pi ab$$

Triangle Special

$$A = 1/2 ab \sin\theta$$

Equilateral:

$$A = (\sqrt{3}/4)l^2$$

Isosceles:

$$A = b/4 \times \sqrt{(4a^2 - b^2)}$$

Solid Geometry

Sphere:

$$\text{Surface area} = 4\pi r^2$$

$$\text{Volume} = 4/3 \pi r^3$$

Cylinder:

$$\text{Surface area} = 2\pi r^2 + 2\pi rh$$

$$\text{Volume} = \pi r^2 h$$

Cone:

$$\text{Volume} = 1/3 \pi r^3$$

Rectangular prism:

$$\text{Surface area} = 2(LW + LH + WH)$$

$$\text{Volume} = LWH$$

Cube:

$$\text{Surface area} = 6s^2$$

COORDINATE GEOMETRY + CONICS

Distance Formula

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

Midpoint

$$M = ((x_1 + x_2)/2, (y_1 + y_2)/2)$$

Slope

$$m = (y_2 - y_1) / (x_2 - x_1)$$

Equation of a Line

Slope-intercept:

$$y = mx + c$$

Point-slope:

$$y - y_1 = m(x - x_1)$$

Standard form:

$$ax + by = c$$

or

$$ax + by - c = 0$$

Circle

$$(x - h)^2 + (y - k)^2 = r^2$$

General form:

$$x^2 + y^2 + 2gx + 2fy + c = 0$$

Centre = $(-g, -f)$

Radius = $\sqrt{g^2 + f^2 - c}$

Parabola

$$y - k = a(x - h)^2$$

or

$$x - h = a(y - k)^2$$

Ellipse

$$(x - h)^2 / a^2 + (y - k)^2 / b^2 = 1$$

Hyperbola

$$(x - h)^2 / a^2 - (y - k)^2 / b^2 = 1$$

TRIGONOMETRY

Basic Identities

$$\sec\theta = 1 / \cos\theta$$

$$\cot\theta = 1 / \tan\theta$$

Reciprocal Functions

$$\sin\theta \leftrightarrow \csc\theta$$

$$\cos\theta \leftrightarrow \sec\theta$$

$$\tan\theta \leftrightarrow \cot\theta$$

Pythagorean Identities

$$\sin^2\theta + \cos^2\theta = 1$$

$$1 + \tan^2\theta = \sec^2\theta$$

$$1 + \cot^2\theta = \csc^2\theta$$

Special Angle Values

θ	Rad	$\sin\theta$	$\cos\theta$	$\tan\theta$
0°	0	0	1	0
30°	$\pi/6$	$1/2$	$\sqrt{3}/2$	$1/\sqrt{3}$
45°	$\pi/4$	$1/\sqrt{2}$	$1/\sqrt{2}$	1
60°	$\pi/3$	$\sqrt{3}/2$	$1/2$	$\sqrt{3}$
90°	$\pi/2$	1	0	—

$\tan(\theta)$ values

$0^\circ \rightarrow 0$
 $30^\circ \rightarrow 1/\sqrt{3}$
 $45^\circ \rightarrow 1$
 $60^\circ \rightarrow \sqrt{3}$
 $90^\circ \rightarrow -$

cos(θ) values

$0^\circ \rightarrow 1$
 $30^\circ \rightarrow \sqrt{3}/2$
 $45^\circ \rightarrow 1/\sqrt{2}$
 $60^\circ \rightarrow 1/2$
 $90^\circ \rightarrow 0$

sin(θ)

0°	30°	45°	60°	90°
0	$1/2$	$1/\sqrt{2}$	$\sqrt{3}/2$	1

HYDROGEN SERIES + CONSTANTS

Hydrogen Spectral Series

Lyman $\rightarrow n \rightarrow 1 \rightarrow$ UV
Balmer $\rightarrow n \rightarrow 2 \rightarrow$ Visible
Paschen $\rightarrow n \rightarrow 3 \rightarrow$ Infrared
Brackett $\rightarrow n \rightarrow 4 \rightarrow$ Infrared
Pfund $\rightarrow n \rightarrow 5 \rightarrow$ Infrared
Humphrey $\rightarrow n \rightarrow 6 \rightarrow$ Infrared

Formula:

$$1/\lambda = R (1/n_1^2 - 1/n_2^2)$$

Fundamental Constants

Avogadro constant (NA)
 $= 6.02 \times 10^{23} \text{ mol}^{-1}$

Boltzmann constant (kB)
 $= 1.38 \times 10^{-23} \text{ J/K}$

Gas constant (R)
 $= 8.31 \text{ J/(mol}\cdot\text{K)}$

Coulomb constant (k)
 $= 9.0 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$

Permeability of vacuum (μ_0)
 $= 4\pi \times 10^{-7} \text{ H/m}$

Permittivity of vacuum (ϵ_0)
 $= 8.85 \times 10^{-12} \text{ F/m}$

Stefan–Boltzmann constant (σ)
 $= 5.67 \times 10^{-8} \text{ W/(m}^2\text{K}^4)$

Rydberg constant (RH)
= $1.097 \times 10^7 \text{ m}^{-1}$

Bohr radius (a_0)
= $5.29 \times 10^{-11} \text{ m}$

Faraday constant (F)
= 96485 C/mol

ELECTROMAGNETIC SPECTRUM + PARTICLES

SI Prefixes

tera (T) = 10^{12}
giga (G) = 10^9
mega (M) = 10^6
kilo (k) = 10^3
centi (c) = 10^{-2}
milli (m) = 10^{-3}
micro (μ) = 10^{-6}
nano (n) = 10^{-9}
pico (p) = 10^{-12}

Electromagnetic Spectrum

Gamma rays → $< 10^{-12} \text{ m}$
X-rays → $10^{-12} - 10^{-8} \text{ m}$
Ultraviolet → $10^{-8} - 4 \times 10^{-7} \text{ m}$
Visible → $4 \times 10^{-7} - 7 \times 10^{-7} \text{ m}$
Infrared → $7 \times 10^{-7} - 10^{-3} \text{ m}$
Microwaves → $10^{-3} - 1 \text{ m}$
Radio waves → $> 1 \text{ m}$

Uses:

- Cancer treatment
- Medical imaging
- Sterilisation
- Vision
- Heat detection
- Radar
- Communication

Order (High frequency → Low)

Gamma → X-ray → UV → Visible → IR → Microwave → Radio

Visible Light Spectrum (Wavelength)

Red → 380–450 nm
Orange → 450–495 nm
Yellow → 495–570 nm
Green → 570–590 nm
Blue → 590–620 nm

Indigo → 620–750 nm

Violet → 420–450 nm

Mnemonic: **ROYGBIV**

Sub-Atomic Particles

Proton → +1 1.67×10^{-27} kg

Neutron → 0 1.67×10^{-27} kg

Electron → -1 9.11×10^{-31} kg

Quarks

Up (u) → +2/3

Down (d) → -1/3

Strange (s) → -1/3

Charm (c) → +2/3

Bottom (b) → -1/3

Top (t) → +2/3

Example:

Proton = uud

Neutron = udd

Leptons

Electron → -1

Muon → -1

Tau → -1

Electron neutrino → 0

Muon neutrino → 0

Tau neutrino → 0

Force Carrier Particles (Bosons)

Photon → 0

Gluon → 0

W⁺ boson → +1

W⁻ boson → -1

Z boson → 0

Scalar particle:

Higgs boson → 0

Total fundamental particles = 17

Discoveries

Proton → Rutherford

Electron → J.J. Thomson

Neutron → James Chadwick

RADIOACTIVITY + PHYSICS BASICS

Types of Radioactive Decay

Alpha (α)
Beta (β)
Gamma (γ)

Particles emitted:
 $\alpha \rightarrow$ Helium nucleus
 $\beta \rightarrow$ Electron
 $\gamma \rightarrow$ Electromagnetic radiation

Example:
 $^{238}\text{U} \rightarrow ^{234}\text{Th} + \alpha$

Resistor Colour Codes

Colour Digit Multiplier

Black	0	10^0
Brown	1	10^1
Red	2	10^2
Orange	3	10^3
Yellow	4	10^4
Green	5	10^5
Blue	6	10^6
Violet	7	10^7
Grey	8	10^8
White	9	10^9

Mnemonic: **BB ROY Great Britain Very Good Wife**

Moment of Inertia (Common Shapes)

Ring $\rightarrow MR^2$
Disc $\rightarrow \frac{1}{2}MR^2$
Sphere $\rightarrow \frac{2}{5}MR^2$
Rod (centre) $\rightarrow \frac{1}{12}MR^2$
Rod (end) $\rightarrow \frac{1}{3}MR^2$

Dimensional Formula

Velocity $\rightarrow LT^{-1}$
Acceleration $\rightarrow LT^{-2}$
Force $\rightarrow MLT^{-2}$
Energy $\rightarrow ML^2T^{-2}$
Power $\rightarrow ML^2T^{-3}$
Pressure $\rightarrow ML^{-1}T^{-2}$

Optics Sign Convention

Object distance $\rightarrow$ negative
Image distance $\rightarrow$ positive
Focal length (convex) $\rightarrow$ positive
Focal length (concave) $\rightarrow$ negative

SOUND, REFRACTION, THERMODYNAMICS

Speed of Sound in Different Media

Air → 343 m/s
Water → 1480 m/s
Steel → 5960 m/s

Fact: Sound travels fastest in solids.

Refractive Indices

Material Refractive Index

Vacuum	1.000
Air	1.0003
Water	1.33
Glass	1.5
Diamond	2.42

Thermodynamic Processes

Isothermal → Temperature is constant
Adiabatic → No heat exchange
Isobaric → Pressure is constant
Isochoric → Volume is constant

Isothermal: $T = \text{constant}$
For ideal gas: $PV = \text{constant}$

Adiabatic: $Q = 0$
For ideal gas: $PV^\gamma = \text{constant}$

Where $\gamma = C_p / C_v$

Work Done

$$W = P\Delta V$$

Astronomical Units

1 AU = 1.496×10^{11} m
1 Light year = 9.46×10^{15} m
1 Parsec = 3.086×10^{16} m

Circuit Components Behaviour

Resistor → limits current
Capacitor → stores charge
Inductor → stores magnetic energy
Diode → allows one direction current
Transistor → switching / amplification

Logic Gates (Boolean)

AND → A · B
OR → A + B
NOT → $\bar{A}$

LOGIC, BIO + SOLAR SYSTEM

Logic Gates

NAND → $(A \cdot B)'$
NOR → $(A + B)'$
XOR → $A \oplus B$

Solar System Data

Planet	Distance from Sun (AU)	Day Length
Mercury	0.39	59 days
Venus	0.72	243 days
Earth	1.00	24 hrs
Mars	1.52	24.6 hrs
Jupiter	5.20	10 hrs
Saturn	9.58	10.7 hrs
Uranus	19.2	17 hrs
Neptune	30.1	16 hrs

Important Figures

Sun mass = 1.989×10^{30} kg
Earth radius = 6371 km
Earth gravity = 9.81 m/s²

Biology Topics

- Heart Chambers and Valves
- Brain Hormones
- Enzymes
- Biochemistry (Macromolecules)
- Immunology
- Microbiology
- Molecular Genetics
- Types of RNA
- Electron Transport Chain
- Menstrual Cycle Phases
- Nucleic Acids and Protein Synthesis
- Cellular Respiration
- Excretion and Homeostasis
- Mendelian Genetics
- Genetic Code
- Phenotypic Ratios
- Cranial Nerves
- Heart Chambers
- Dental Formulas
- Skeletal Systems
- Hormones and Glands
- Vitamins

- Essential Minerals
- Taxonomy Hierarchy
- Blood Groups (ABO and Rh Systems)
- Muscle Types Comparison

CALCULUS + STATISTICS + BIO LIST

Biology Topics

- Plant Hormones
- Insect Body Parts
- Brain Parts and Function
- Digestive Enzymes
- Cell Cycle and Mitosis Stages
- Meiosis Key Events
- Chromosome Numbers
- Nephron Structure and Functions
- Muscle Types Comparison
- Carbs, Proteins, Lipids
- ATP Yield per Glucose
- Photosynthesis (C3 vs C4 vs CAM)
- Hardy–Weinberg Equilibrium

Calculus

Derivative of x^n :

$$d/dx (x^n) = nx^{n-1}$$

Product Rule:

$$d/dx [u(x)v(x)] = u'(x)v(x) + u(x)v'(x)$$

Quotient Rule:

$$d/dx (u/v) = (u'v - uv') / v^2$$

Chain Rule:

$$d/dx f(g(x)) = f'(g(x)) \cdot g'(x)$$

Integration of x^n :

$$\int x^n dx = x^{n+1} / (n + 1) + C$$

Definite Integral:

$$\int_a^b f(x)dx = F(b) - F(a)$$

Statistics & Probability

Mean:

$$\bar{x} = \Sigma x / n$$

OR

$$\Sigma fx / \Sigma f$$

Variance:

$$\sigma^2 = \Sigma (x_i - \bar{x})^2 / n$$

Standard deviation:

$$\sigma = \sqrt{\sigma^2}$$

Probability:

$P(A) = \text{Number of favourable outcomes} / \text{Total outcomes}$

MATRICES, PROBABILITY, DIVISIBILITY

Combination

$${}^nC_r = n! / [r!(n - r)!]$$

Permutation

$${}^nP_r = n! / (n - r)!$$

Matrices

Determinant (2×2):

$$\begin{vmatrix} a & b \\ c & d \end{vmatrix} = ad - bc$$

Inverse:

$$A^{-1} = 1/(ad - bc) \begin{bmatrix} d & -b \\ -c & a \end{bmatrix}$$

Sum to Infinity (GP)

$$S_{\infty} = a / (1 - r), \quad r < 1$$

Quadratic Discriminant

$$D = b^2 - 4ac$$

$D > 0 \rightarrow$ Two real roots

$D = 0 \rightarrow$ One real root

$D < 0 \rightarrow$ Complex roots

Probability Rules

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

Bayes Theorem:

$$P(A/B) = [P(B/A) P(A)] / P(B)$$

Divisibility Rules

By 2 $\rightarrow$ Last digit even

By 3 $\rightarrow$ Sum divisible by 3

By 4 $\rightarrow$ Last 2 digits divisible by 4

By 5 $\rightarrow$ Last digit 0 or 5

By 6 $\rightarrow$ Divisible by 2 and 3

By 7 $\rightarrow$ Double last digit, subtract from rest, result divisible by 7

By 8 → Last three digits divisible by 8

By 9 → Sum of digits divisible by 9

By 10 → Last digit 0

MENTAL MATH + MEMORY AIDS

Multiplication Tricks

By 3:

$$14 \times 3 = 14 \times 10 + 42 = 140 + 52 = 192$$

By 125:

$$10 \times 125 = (10 \times 1000)/8 = 250$$

Percentage Multiplication

By 50% → $\times 1/2$

By 25% → $\times 100 \div 4$

By 75% → $\times 3/4$

By 125% → $\times 5/4$

Mental Math Rules

Multiply by 99 → $\times 100 - \text{number}$

$$99 \times 99 = 9900 - 99 = 9801$$

Subtract from 1000:

Subtract each digit from 9

Example:

$$1000 - 879 = 121$$

Multiplication Patterns

$\times 101$ → repeat number

$$23 \times 101 = 2323$$

$\times 15$ → $\times 10 + \text{half}$

$$60 \times 15 = 600 + 30 = 630$$

Multiplying by ($\times 12$) → $\times 10 + 26$

$$13 \times 12 = 130 + 26 = 156$$

ULTIMATE MULTIPLICATION SPEED SHEET

1. CORE BENCHMARK MULTIPLICATIONS

♦ Multiply by 10, 100, 1000

- $\times 10$ → add one zero
- $\times 100$ → add two zeros
- $\times 1000$ → add three zeros

Example:

$$45 \times 100 = 4500$$

Multiply by 5

Multiply by 10, then divide by 2

Example:

$$48 \times 5 = (48 \times 10) / 2 = 480 / 2 = 240$$

Multiply by 25

Multiply by 100, divide by 4

Example:

$$64 \times 25 = (64 \times 100) / 4 = 6400 / 4 = 1600$$

Multiply by 50

Multiply by 100, divide by 2

Example:

$$36 \times 50 = (36 \times 100) / 2 = 3600 / 2 = 1800$$

Multiply by 125

Multiply by 1000, divide by 8

Example:

$$32 \times 125 = (32 \times 1000) / 8 = 32000 / 8 = 4000$$

2. MULTIPLY BY 9 (FAST METHOD)

Multiply by 10 and subtract the number

Example:

$$47 \times 9 = 470 - 47 = 423$$

3. MULTIPLY BY 11 (SUPER FAST)

Add adjacent digits

Example:

$$52 \times 11 \rightarrow 5 \ (5+2) \ 2 = 572$$

Example:

$$79 \times 11 \rightarrow 7 \ (7+9) \ 9 = 869$$

4. MULTIPLY BY 12

$\times 10 + 2 \times$

Example:

$$23 \times 12 = 230 + 46 = 276$$

5. MULTIPLY BY 15

$\times 10 + \text{half}$

Example:

$$40 \times 15 = 400 + 20 = 420$$

6. MULTIPLY BY 20–99 (NEAR 100 METHOD)

Numbers close to 100

Use base 100

Example:

$$97 \times 96$$

$$97 - 100 = -3$$

$$96 - 100 = -4$$

$$\text{Left: } 97 - 4 = 93$$

$$\text{Right: } (-3 \times -4) = 12$$

Answer: **9312**

7. MULTIPLY NUMBERS NEAR 50

Use base 50

Example:

$$48 \times 52$$

$$48 - 50 = -2$$

$$52 - 50 = +2$$

$$\text{Left: } 48 + 2 = 50$$

$$\text{Right: } -2 \times 2 = -4$$

Answer: **2496**

8. MULTIPLY NUMBERS NEAR 1000

Example:

$$1003 \times 998$$

+3 and -2

$$\text{Left: } 1003 - 2 = 1001$$

$$\text{Right: } (3 \times -2) = -6$$

Answer: **1000994**

9. MULTIPLY BY FRACTIONS / PERCENTAGES

◆ 50% → divide by 2

◆ 25% → divide by 4

◆ 75% → $\times 3 \div 4$

◆ 150% → $\times 1.5$

Example:

$$80 \times 75\% = (80 \times 3) / 4 = 60$$

10. MULTIPLY BY DECIMALS

Ignore decimal, multiply, then adjust

Example:

$$2.5 \times 4 = 10$$

11. CROSS MULTIPLICATION (2-DIGIT $\times$ 2-DIGIT)

Example:

$$23 \times 14$$

$$(20 \times 10) + (20 \times 4) + (3 \times 10) + (3 \times 4) \\ = 200 + 80 + 30 + 12 = 322$$

12. VERTICAL & CROSS METHOD (FAST)

Example:

$$34 \times 12$$

$$\text{Step 1: } 4 \times 2 = 8$$

$$\text{Step 2: } (3 \times 2 + 4 \times 1) = 6 + 4 = 10$$

$$\text{Step 3: } 3 \times 1 = 3$$

Answer: **408**

13. MULTIPLY NUMBERS ENDING IN 5

Use: $n5 \times n5$

Example:

$$25^2 = 2 \times 3 \mid 25 = 625$$

Example:

$$75^2 = 7 \times 8 \mid 25 = 5$$

14. MULTIPLY NUMBERS CLOSE TO EACH OTHER

Example:

$$43 \times 47$$

$$\text{Mean} = 45$$

$$\text{Use: } (45^2 - 2^2)$$

$$= 2025 - 4 = 2021$$

15. MULTIPLY LARGE NUMBERS (BREAK METHOD)

Example:

$$123 \times 45$$

$$= 123 \times (40 + 5)$$

$$= 4920 + 615 = 5535$$

16. MULTIPLICATION PATTERNS

◆ Repeating numbers

Example:

$$111 \times 111 = 12321$$

◆ Same first digit, last digits sum to 10

Example:

$$23 \times 27$$

$$2 \times 3 = 6$$

$$3 \times 7 = 21$$

Answer: **621**

Memory Aids

1. Order of operations: **PEMDAS**
2. π memory:
"May I have a large container of coffee" (3.1415926...) -
Number of letters in each word gives (π)
3. Metric Prefixes "King Henry Died By Drinking Chocolate Drink" (Kilo, Hecto, Deca, Base, Deci, Centi, Milli)
4. Roman Numerals: "I value Xylophones Like Cows Dig Milk" I=1, V=5, X=10, L=50, C=100, D=500, M=1000

PHYSICS FORMULAS

Equations of Motion

$$v = u + at$$

$$s = ut + \frac{1}{2} at^2$$

$$v^2 = u^2 + 2as$$

$$s = \frac{1}{2} (u + v)t$$

Forces

$$F = ma$$

Weight:

$$W = mg$$

Momentum:

$$p = mv$$

Circular Motion

$$a_c = v^2 / r$$

$$F_c = mv^2 / r$$

Energy & Work

Work:

$$W = Fd \cos\theta$$

$$KE = \frac{1}{2} mv^2$$

$$PE = mgh$$

Power:
 $P = W/t$ or $P = Fv$

Pressure:
 $P = F/A$

Density:
 $\rho = m/V$

Hooke's Law:
 $F = kx$

Impulse:
 $J = F\Delta t$

Wave speed:
 $v = f\lambda$

Frequency:
 $f = 1/T$

Snell's Law:
 $n_1 \sin\theta_1 = n_2 \sin\theta_2$

Mirror:
 $1/f = 1/u + 1/v$

Lens:
 $1/f = 1/v - 1/u$

Magnification:
 $m = v/u$

Electricity

Ohm's law:
 $V = IR$

Series:
 $R_T = R_1 + R_2$

Parallel:
 $1/R_T = 1/R_1 + 1/R_2$

Capacitance

$C = Q/V$

Energy stored in Capacitor:
 $E = 1/2 CV^2$

Electromagnetism

Faraday:
 $\varepsilon = -N d\Phi/dt$

Lenz Law: The induced emf opposes the change in flux

Magnetic force on moving charge:
 $F = qvB \sin\theta$

Molar Mass Table

Acetic acid	$\text{CH}_3\text{COOH} \rightarrow 60.05$
Hydrochloric acid	$\text{HCl} \rightarrow 36.46$
Sulfuric acid	$\text{H}_2\text{SO}_4 \rightarrow 98.08$
Ammonia	$\text{NH}_3 \rightarrow 17.03$
Sodium hydroxide	$\text{NaOH} \rightarrow 40.00$
Calcium carbonate	$\text{CaCO}_3 \rightarrow 100.09$
Sodium chloride	$\text{NaCl} \rightarrow 58.44$
Methane	$\text{CH}_4 \rightarrow 16.04$
Benzene	$\text{C}_6\text{H}_6 \rightarrow 78.11$
Ethanol	$\text{C}_2\text{H}_5\text{OH} \rightarrow 46.07$

Groups

Group 1: Li, Na, K, Rb, Cs, Fr "Like Naughty Kids Rub Cats Fur"

Group 2: Be, Mg, Ca, Sr, Ba, Ra "Bearded Muggers came Straight Back Rapidly"

Diatomic

$\text{H}_2, \text{N}_2, \text{F}_2, \text{O}_2, \text{I}_2, \text{Cl}_2, \text{Br}_2$ "Have no fear of Ice Cold Beer"

Redox Reactions

LEO (the Lion says GER) $\rightarrow$ Loss of electrons is oxidation
 GER $\rightarrow$ Gain of electrons is reduction

Polyatomic Ions (Polyatomic ions, Their Symbols, and Charges)

Nitrite $\rightarrow \text{NO}_2^- \rightarrow -1$
 Sulfate $\rightarrow \text{SO}_4^{2-} \rightarrow -2$
 Sulfite $\rightarrow \text{SO}_3^{2-} \rightarrow -2$
 Bisulfate $\rightarrow \text{HSO}_4^- \rightarrow -1$
 Carbonate $\rightarrow \text{CO}_3^{2-} \rightarrow -2$
 Bicarbonate $\rightarrow \text{HCO}_3^- \rightarrow -1$
 Phosphate $\rightarrow \text{PO}_4^{3-} \rightarrow -3$
 Biphosphate $\rightarrow \text{HPO}_4^{2-} \rightarrow -2$
 Dihydrogen phosphate $\rightarrow \text{H}_2\text{PO}_4^- \rightarrow -1$
 Permanganate $\rightarrow \text{MnO}_4^- \rightarrow -1$
 Chromate $\rightarrow \text{CrO}_4^{2-} \rightarrow -2$
 Dichromate $\rightarrow \text{Cr}_2\text{O}_7^{2-} \rightarrow -2$
 Cyanide $\rightarrow \text{CN}^- \rightarrow -1$
 Acetate $\rightarrow \text{CH}_3\text{COO}^- / \text{C}_2\text{H}_3\text{O}_2^- \rightarrow -1$
 Oxalate $\rightarrow \text{C}_2\text{O}_4^{2-} \rightarrow -2$
 Thiosulfate $\rightarrow \text{S}_2\text{O}_3^{2-} \rightarrow -2$
 Hypochlorite $\rightarrow \text{ClO}^- \rightarrow -1$
 Chlorite $\rightarrow \text{ClO}_2^- \rightarrow -1$
 Chlorate $\rightarrow \text{ClO}_3^- \rightarrow -1$
 Perchlorate $\rightarrow \text{ClO}_4^- \rightarrow -1$

SALTS TABLE (Salt Name, Symbol, Parent Acid and Parent Base)

Sodium carbonate $\rightarrow \text{Na}_2\text{CO}_3 \rightarrow \text{H}_2\text{CO}_3 \rightarrow \text{NaOH}$
 Sodium hydrogen carbonate $\rightarrow \text{NaHCO}_3 \rightarrow \text{H}_2\text{CO}_3 \rightarrow \text{NaOH}$

Calcium sulfate $\rightarrow$ $\text{CaSO}_4 \rightarrow \text{H}_2\text{SO}_4 \rightarrow \text{KOH}$
Copper (II) sulfate $\rightarrow$ $\text{CuSO}_4 \rightarrow \text{H}_2\text{SO}_4 \rightarrow \text{NaOH}$
Sodium sulfate $\rightarrow$ $\text{Na}_2\text{SO}_4 \rightarrow \text{H}_2\text{SO}_4 \rightarrow \text{NH}_4\text{OH}$
Potassium nitrate $\rightarrow$ $\text{KNO}_3 \rightarrow \text{HNO}_3 \rightarrow \text{NH}_4\text{OH}$
Sodium nitrate $\rightarrow$ $\text{NaNO}_3 \rightarrow \text{HNO}_3 \rightarrow \text{NH}_4\text{OH}$
Ammonium chloride $\rightarrow$ $\text{NH}_4\text{Cl} \rightarrow \text{HCl} \rightarrow \text{NH}_4\text{OH}$
Ammonium sulfate $\rightarrow$ $(\text{NH}_4)_2\text{SO}_4 \rightarrow \text{H}_2\text{SO}_4 \rightarrow \text{NH}_4\text{OH}$
Ammonium nitrate $\rightarrow$ $\text{NH}_4\text{NO}_3 \rightarrow \text{HNO}_3 \rightarrow \text{Ca}(\text{OH})_2$
Calcium chloride $\rightarrow$ $\text{CaCl}_2 \rightarrow \text{HCl} \rightarrow \text{Mg}(\text{OH})_2$
Magnesium sulfate $\rightarrow$ $\text{MgSO}_4 \rightarrow \text{H}_2\text{SO}_4$

TRANSITION ELEMENTS

Scandium $\rightarrow$ Sc $\rightarrow$ 21
Titanium $\rightarrow$ Ti $\rightarrow$ 22
Vanadium $\rightarrow$ V $\rightarrow$ 23
Chromium $\rightarrow$ Cr $\rightarrow$ 24
Manganese $\rightarrow$ Mn $\rightarrow$ 25
Iron $\rightarrow$ Fe $\rightarrow$ 26
Cobalt $\rightarrow$ Co $\rightarrow$ 27
Nickel $\rightarrow$ Ni $\rightarrow$ 28
Copper $\rightarrow$ Cu $\rightarrow$ 29
Zinc $\rightarrow$ Zn $\rightarrow$ 30
Yttrium $\rightarrow$ Y $\rightarrow$ 39

SECOND TRANSITION BLOCK

Zirconium $\rightarrow$ Zr $\rightarrow$ 40
Niobium $\rightarrow$ Nb $\rightarrow$ 41
Molybdenum $\rightarrow$ Mo $\rightarrow$ 42

Technetium $\rightarrow$ Tc $\rightarrow$ 43
Ruthenium $\rightarrow$ Ru $\rightarrow$ 44
Rhodium $\rightarrow$ Rh $\rightarrow$ 45
Palladium $\rightarrow$ Pd $\rightarrow$ 46
Silver $\rightarrow$ Ag $\rightarrow$ 47
Cadmium $\rightarrow$ Cd $\rightarrow$ 48

ORES (Metal, Ore Name, Chemical Formula)

Copper $\rightarrow$ Chalcopyrite $\rightarrow$ CuFeS_2
Copper $\rightarrow$ Malachite $\rightarrow$ $\text{Cu}_2\text{CO}_3(\text{OH})_2$
Copper $\rightarrow$ Cuprite $\rightarrow$ Cu_2O

Zinc $\rightarrow$ Zinc blende (Sphalerite) $\rightarrow$ ZnS
Zinc $\rightarrow$ Calamine $\rightarrow$ ZnCO_3

Lead $\rightarrow$ Galena $\rightarrow$ PbS
Tin $\rightarrow$ Cassiterite $\rightarrow$ SnO_2
Mercury $\rightarrow$ Cinnabar $\rightarrow$ HgS

Silver $\rightarrow$ Argentite $\rightarrow$ Ag_2S
Silver $\rightarrow$ Cerargyrite $\rightarrow$ AgCl

Gold $\rightarrow$ Native gold $\rightarrow$ Au

Chromium $\rightarrow$ Chromite $\rightarrow$ FeCr_2O_4
Manganese $\rightarrow$ Pyrolusite $\rightarrow$ MnO_2
Nickel $\rightarrow$ Pentlandite $\rightarrow$ $(\text{Fe},\text{Ni})_9\text{S}_8$

Titanium $\rightarrow$ Rutile $\rightarrow$ TiO_2
Titanium $\rightarrow$ Ilmenite $\rightarrow$ FeTiO_3

Magnesium → Magnesite → MgCO_3
Calcium → Calcite → CaCO_3
Sodium → Halite → NaCl
Potassium → Sylvite → KCl

ALLOYS AND THEIR COMPOSITIONS

Brass → Copper + Zinc
Bronze → Copper + Tin
Steel → Iron + Carbon
Stainless steel → Iron + Chromium + Nickel + Carbon
Duralumin → Aluminium + Copper + Magnesium + Manganese
Solder → Lead + Tin
Nichrome → Nickel + Chromium
Amalgam → Mercury + Silver + Copper
Gunmetal → Copper + Tin + Zinc
Invar → Iron + Nickel
Magnalium → Aluminium + Magnesium
Pewter → Tin + Copper + Antimony
German silver → Copper + Nickel + Zinc
Alnico → Aluminium + Nickel + Cobalt + Iron
Constantan → Copper + Nickel
Monel metal → Nickel + Copper

BIOLOGY

Formulae and Quantitative Relations

Population Growth (Exponential):

$$N_t = N_0 e^{rt}$$

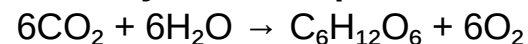
Where N_t = population at time t , N_0 = initial population and r = growth rate

Logistic Growth:

$$N_t = K / [1 + ((K - N_0)/N_0)e^{-rt}]$$

Where K = carrying capacity

Photosynthesis Equation:



Respiratory Quotient:

$$\text{RQ} = \text{CO}_2 \text{ produced} / \text{O}_2 \text{ consumed}$$

Hardy–Weinberg Equation:

$$p^2 + 2pq + q^2 = 1$$

where:

p = frequency of dominant allele

q = frequency of recessive allele

MEMORY / CHEMISTRY

Essential Amino Acids:

“PVT TIM HALL”

Phenylalanine, Valine, Threonine, Tryptophan,
Isoleucine, Methionine, Histidine, Arginine,
Leucine and Lysine

Activity Series of Metals:

“Please Stop Calling Me A Cute Zebra, I Like Her Call Smart Goat”

Potassium, Sodium, Calcium, Magnesium, Aluminium,
Carbon, Zinc, Iron, Lead, Hydrogen

Order of Orbitals:

“Sober Physicists Don’t Find Giraffes Hiding in Kitchens”

s, p, d, f, g, h, i, j, k

Hydrogen Bonds:

“Hydrogen is FON!”

Bonds with Fluorine, Oxygen, Nitrogen

Prefixes for Carbon Chains:

“Monkeys Eat Peeled Bananas”

Meth-, Eth-, Prop-, But-

MEMORIZATION / BIOLOGY

Classification of Living Things

“Dear King Philip Came Over For Good Soup”

Kingdom, Phylum, Class, Order, Family, Genus, Species

DNA Base Pairing

“A pairs with T, C pairs with G”

Stages of Mitosis

“I Passed My Anatomy Test”

Interphase, Prophase, Metaphase, Anaphase, Telophase

Cranial Nerves

“Oh, oh, oh, to touch and feel very green vegetables, AH!”

Olfactory, Optic, Oculomotor, Trochlear, Trigeminal,
Abducens, Facial, Vestibulocochlear, Glossopharyngeal,
Vagus, Accessory, Hypoglossal

Photosynthesis Steps

“Light, Water, CO₂ → Glucose, Oxygen”

FORMULAE (BIO/PHYSICS)

Genotype frequency:

$$p + q = 1$$

Osmotic Pressure:

$$\pi = iMRT$$

Surface Area to Volume Ratio:

$$\text{Surface Area} / \text{Volume}$$

Cardiac Output:

$$CO = \text{Stroke Volume} \times \text{Heart Rate}$$

Blood Pressure:

$$BP = \text{Cardiac Output} \times \text{Peripheral Resistance}$$

BMI (Body Mass Index):

$$BMI = \text{Weight (kg)} / \text{Height (m)}^2$$

Magnification:

$$\text{Magnification} = \text{Initial size} / \text{Actual size}$$

HORMONES (HYPOTHALAMUS)

1. Corticotropin-releasing hormone (CRH) – Triggers ACTH release
2. Dopamine – Inhibits prolactin release

3. Gonadotropin-releasing hormone (GnRH) – Triggers FSH and LH release
 4. Growth hormone-releasing hormone (GHRH) – Triggers GH release
 5. Somatostatin – Inhibits GH and TSH
 6. Thyrotropin-releasing hormone – Triggers TSH
-

PITUITARY GLAND

7. Adrenocorticotrophic hormone (ACTH) – Stimulates adrenal glands
-

ENDOCRINE SYSTEM

Antidiuretic hormone (ADH)

Regulates water balance in kidneys

FSH

Controls sperm production

Growth hormone (GH)

Stimulates growth and metabolism

LH

Controls testosterone and estrogen production

Oxytocin

Triggers childbirth and milk flow

Prolactin

Stimulates milk production

Thyroid

Stimulates thyroid gland

Thyroid & Parathyroid

Thyroxine (T4) – regulates metabolism

Triiodothyronine (T3) – active metabolism regulator

Calcitonin – lowers blood calcium

Parathyroid hormone – increases calcium

Pancreas

Insulin – lowers blood sugar

Glucagon – raises blood sugar

Amylin – delays gastric emptying

Adrenal Glands

Aldosterone – regulates salt and water

Cortisol – stress and metabolism

MORE HORMONES

Adrenaline – fight or flight

Noradrenaline – increases BP

DHEA – precursor to sex hormones

Gonads

Estrogen – female development

Progesterone – prepares uterus

Testosterone – male development

Inhibin – inhibits FSH

Digestive System Hormones

Ghrelin – hunger

Leptin – fullness

Gastrin – stomach acid

CCK – digestion

Secretin – water balance

GLP-1 – insulin release

Other Hormones

Melatonin – sleep

Erythropoietin – RBC production

Renin – blood pressure

Thymosin – immune cells

hCG – pregnancy
ANP – lowers BP
Serotonin – mood

Plant Hormones

Auxin – cell elongation
Gibberellin – stem growth
Cytokinin – cell division
Ethylene – fruit ripening
Absciscic acid – stress response

RNA Types

mRNA
tRNA
rRNA

Digestive Enzymes Table

Amylase → Starch → Maltose
Pepsin → Protein → Peptides
Lipase → Lipid → Fatty acids + glycerol
Maltase → Maltose → Glucose

Chromosome Numbers

Human → 46
Fruit fly → 8
Maize → 20
Rice → 24
Dog → 78

Humans have 23 pairs of chromosomes

Nephron Structure

Glomerulus
Bowman's capsule
Proximal tubule
Loop of Henle
Distal tubule
Collecting duct

Muscle Types

Skeletal → Voluntary → attached to bones
Smooth → Involuntary → organs
Cardiac → Involuntary → heart

BLOOD GROUP TABLE

A → Antigen A → Antibody Anti-B
B → Antigen B → Antibody Anti-A
AB → Antigen A and B → No antibodies
O → No antigen → Anti-A and Anti-B

Universal donor → O⁻
Universal recipient → AB⁺

HEART VALVES TABLE

Tricuspid → RA → RV
Bicuspid (Mitral) → LA → LV
Pulmonary → RV → Pulmonary artery
Aortic → LV → Aorta

BRAIN PARTS

Cerebrum → intelligence and memory
Cerebellum → coordination and balance
Medulla oblongata → heartbeat and breathing
Hypothalamus → body temperature

GENETICS DETAILS

Codon = 3 nitrogen bases
Total codons = 64
61 code for amino acids

PHENOTYPIC RATIOS

Monohybrid → 3 : 1
Dihybrid → 9 : 3 : 3 : 1

Test cross → 1 : 1
Incomplete dominance → 1 : 2 : 1
Codominance → 1 : 2 : 1

PHYSICS (ROTATION & GRAVITY)

Conservation of momentum:
 $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

Angular displacement:
 $\theta = \omega t$

Angular velocity:
 $\omega = d\theta/dt$

Angular acceleration:
 $\alpha = d\omega/dt$

Rotational kinematics:
 $\omega = \omega_0 + \alpha t$
 $\theta = \omega_0 t + \frac{1}{2}\alpha t^2$

Moment of inertia:
 $I = \sum mr^2$

Torque:
 $\tau = rF \sin\theta$

Newton's 2nd Law (rotation):
 $\tau = I\alpha$

Angular momentum:
 $L = I\omega$

Gravitational / Orbital

Orbital velocity:
 $v = \sqrt{GM/r}$

Escape velocity:
 $V_{esc} = \sqrt{2GM/r}$

Gravitational Potential Energy:
 $U = -GMm/r$

FLUID MECHANICS

Pressure:
 $P = F/A$

Pressure at depth:
 $P = P_0 + \rho gh$

Buoyant force:
 $F_b = \rho_{\text{fluid}} V_{\text{displaced}} g$

Continuity equation:
 $A_1 V_1 = A_2 V_2$

Bernoulli's equation:
 $P + \frac{1}{2}\rho v^2 + \rho gh = \text{constant}$

HEAT & THERMAL

Thermal expansion:
 $\Delta L = \alpha L_0 \Delta T$

Conduction:
 $Q = kA\Delta T t/d$

Fourier's Law:
 $q = -k dT/dx$

Convection:
 $Q = hA\Delta T t$

Radiation:
 $Q = \sigma eAT^4 t$

WAVES / SHM

Displacement:

$$x = A \sin(\omega t + \phi)$$

Angular frequency:

$$\omega = 2\pi f$$

Period:

$$T = 2\pi/\omega$$

Max velocity:

$$v_{\max} = A\omega$$

Max acceleration:

$$a_{\max} = A\omega^2$$

Spring system:

$$T = 2\pi\sqrt{m/k}$$

Pendulum:

$$T = 2\pi\sqrt{l/g}$$

Energy in SHM:

$$E = \frac{1}{2}kA^2$$

WAVE PROPERTIES

Intensity:

$$I = P/A$$

Sound intensity:

$$I = (\Delta p)^2 / (2\rho v)$$

SOUND / OPTICS

Speed of sound:

$$v = \sqrt{B/\rho}$$

Decibel level:

$$\beta = 10 \log(I/I_0)$$

Doppler Effect:

$$f' = f (v \pm v_o) / (v \mp v_s)$$

Interference:

Constructive:

$$\Delta x = n\lambda$$

Destructive:

$$\Delta x = (n + \frac{1}{2})\lambda$$

Young's double slit:

$$y = n\lambda D/d$$

Fringe width:

$$\beta = \lambda D/d$$

Diffraction grating:

$$d \sin \theta = n \lambda$$

ELECTRICITY & MAGNETISM

Electric field:

$$E = kQ/r^2$$

Electric potential:

$$V = kQ/r$$

Potential energy:

$$U = qV$$

CIRCUITS

Ohm's Law:

$$V = IR$$

Series:

$$R_T = R_1 + R_2 + \dots$$

Parallel:

$$1/R_T = 1/R_1 + 1/R_2 + \dots$$

Power:

$$P = IV = I^2 R = V^2/R$$

MAGNETISM

Magnetic force:

$$F = qvB \sin \theta$$

Force on wire:

$$F = BIL \sin \theta$$

Magnetic field:

$$B = \mu_0 I / 2\pi r$$

Biot-Savart Law:

$$dB = \mu_0 I dl \sin \theta / (4\pi r^2)$$

Magnetic flux:

$$\Phi = BA \cos \theta$$

Induction:

$$E = L(dI/dt)$$

AC CIRCUITS

Capacitive reactance:

$$X_c = 1/\omega C$$

Inductive reactance:

$$X_L = \omega L$$

Impedance:

$$Z = \sqrt{R^2 + (X_L - X_c)^2}$$

RMS:

$$I_{rms} = I_0/\sqrt{2}$$

50 IMPORTANT PHYSICS FORMULAS

1. Speed: $v = d / t$	26. Ohm's Law: $V = I R$
2. Acceleration: $a = (v - u) / t$	27. Electrical Power: $P = V I$
3. Force: $F = m \times a$	28. Electrical Energy: $E = V I t$
4. Weight: $W = m \times g$	29. Resistance: $R = \rho L / A$
5. Gravitational Force: $F = G m_1 m_2 / r^2$	30. Series Resistance: $R = R_1 + R_2 + R_3$
6. Gravitational Potential Energy: $U = - G m_1 m_2 / r$	31. Parallel Resistance: $1/R = 1/R_1 + 1/R_2 + 1/R_3$
7. Kinetic Energy: $KE = 1/2 m v^2$	32. Capacitance: $C = Q / V$
8. Potential Energy (height): $PE = m g h$	33. Energy in Capacitor: $E = 1/2 C V^2$
9. Work: $W = F \times d$	34. Coulomb's Law: $F = k q_1 q_2 / r^2$
10. Power: $P = W / t$	35. Electric Field: $E = F / q$
11. Pressure: $P = F / A$	36. Magnetic Force: $F = q v B \sin \theta$
12. Density: $\rho = m / V$	37. Magnetic Field (Wire): $B = \mu_0 I / (2 \pi r)$
13. Momentum: $p = m v$	38. Magnetic Field (Solenoid): $B = \mu_0 n I$
14. Impulse: $J = F t$	39. Faraday's Law: $E = - N (\Delta \Phi / \Delta t)$
15. Newton's Second Law: $F = \Delta p / \Delta t$	40. Lenz's Law: Direction opposes change in flux
16. Newton's Third Law: $F_1 = - F_2$	41. Electromotive Force: $\epsilon = - \Delta \Phi / \Delta t$
17. Friction: $f = \mu N$	42. Lens Formula: $1/f = 1/v - 1/u$
18. Centripetal Force: $F = m v^2 / r$	43. Magnification: $M = v / u = h_i / h_o$
19. Circular Motion (Period): $T = 2 \pi r / v$	44. Thin Lens Power: $P = 1/f$
20. Simple Harmonic Motion: $a = - \omega^2 x$	45. Ideal Gas Law: $P V = n R T$
21. Period of SHM: $T = 2 \pi / \omega$	46. Thermodynamics (First Law): $\Delta U = Q - W$
22. Hooke's Law: $F = - k x$	47. Efficiency: $\eta = (\text{Output} / \text{Input}) \times 100$
23. Wave Speed: $v = f \lambda$	48. Heat Energy: $Q = m c \Delta T$
24. Reflection of Waves: $\theta_i = \theta_r$	49. Stefan-Boltzmann Law: $E = \sigma A T^4$
25. Sound Speed: $v = f \lambda$	50. Planck's Equation: $E = h f$

EXAMPLES OF SYSTEMS IN THE HUMAN BODY

1. Integumentary System
2. Muscular System
3. Skeletal system
4. Endocrine system
5. Digestive system
6. Respiratory system
7. Excretory system
8. Reproductive system
9. Circulatory system
10. Nervous system
11. Immune system

PARTS OF THE INTEGUMENTARY SYSTEM AND THEIR FUNCTIONS

Epidermis – outermost layer of the skin; provides protection against pathogens, prevents water loss, and forms a barrier against physical damage.

Dermis – inner layer beneath the epidermis; contains blood vessels, nerves, and glands; responsible for nourishment, sensation, and support.

Hypodermis (subcutaneous layer) – layer beneath the dermis; stores fat, insulates the body, and absorbs shock.

Melanin – skin pigment produced in the epidermis; protects the body from harmful ultraviolet (UV) radiation.

Hair – grows from follicles in the skin; provides protection, insulation, and sensitivity to touch.

Hair follicle – structure that produces and anchors hair; responsible for hair growth.

Sebaceous (oil) glands – glands that produce sebum; lubricate the skin and hair and prevent drying and microbial growth.

Sebum – oily substance; keeps skin soft and reduces water loss.

Sweat glands – glands that produce sweat; regulate body temperature and remove small amounts of waste.

Eccrine sweat glands – produce watery sweat; mainly for cooling the body.

Apocrine sweat glands – produce thicker sweat; found in specific areas and contribute to body odor.

Sweat pores – openings on the skin surface; allow sweat to be released.

Nails – hard keratin structures; protect the tips of fingers and toes and assist in grasping.

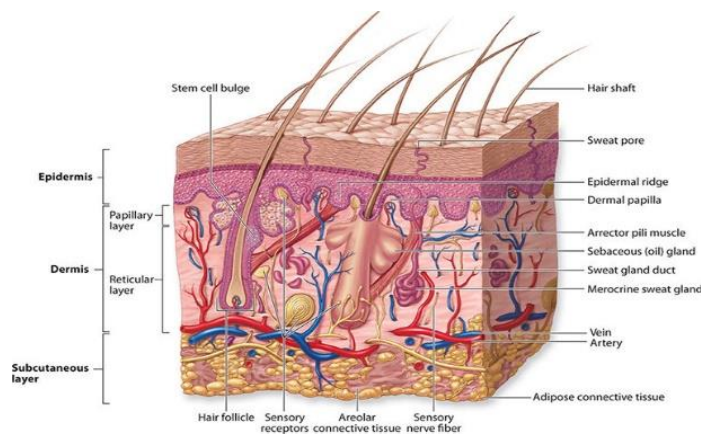
Blood vessels (in dermis) – regulate body temperature by controlling heat loss and supply nutrients to the skin.

Nerve endings – sensory receptors; detect touch, pain, pressure, and temperature.

Keratin – tough structural protein in skin, hair, and nails; provides strength and waterproofing.

Vitamin D synthesis (skin function) – skin produces vitamin D when exposed to sunlight; important for bone health.

An image of the Integumentary System



PARTS OF THE SKELETAL SYSTEM AND THEIR FUNCTIONS.

Bones – rigid structures forming the skeleton; provide support, protect organs, enable movement, and produce blood cells.

Skull – bones of the head; protect the brain and support the face.

Cranium – upper part of the skull; encloses and protects the brain.

Vertebral Column (Spine) – series of vertebrae; supports the body, protects the spinal cord, and allows flexibility.

Ribs – curved bones forming the rib cage; protect the heart and lungs.

Sternum – breastbone; connects ribs and helps protect thoracic organs.

Pelvis (Pelvic girdle) – hip bones; support body weight and protect reproductive organs.

Pectoral Girdle (Shoulder girdle) – clavicle and scapula; attaches arms to the body.

Limbs (Arms and Legs) – bones for movement; enable locomotion and manipulation of objects.

Joints – points where two or more bones meet; allow movement and flexibility.

Cartilage – flexible connective tissue; reduces friction at joints and provides cushioning.

Ligaments – tough tissues connecting bone to bone; stabilize joints.

Tendons – tissues connecting muscle to bone; transmit force for movement.

Bone Marrow – soft tissue inside bones; produces blood cells (red, white, platelets).

Compact Bone – dense outer layer of bone; provides strength and support.

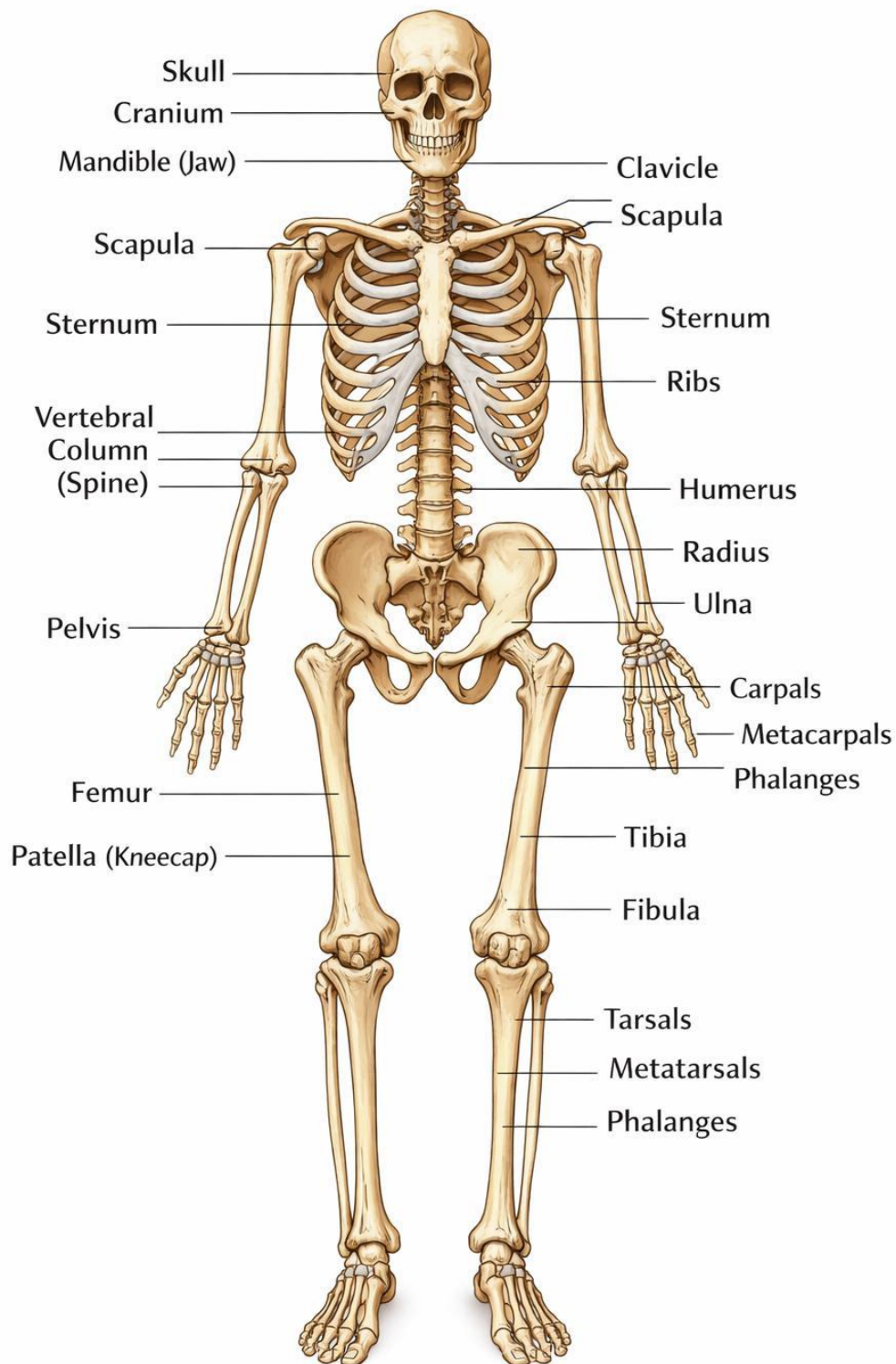
Spongy Bone – porous inner bone; reduces weight and contains marrow.

Calcium (in bones) – mineral stored in bones; provides strength and hardness.

Synovial Fluid – fluid in joints; lubricates and reduces friction.

Patella (Kneecap) – small bone in knee; protects joint and improves movement efficiency.

The Skeletal System



PARTS OF THE MUSCULAR SYSTEM AND THEIR FUNCTIONS

Skeletal muscles – attached to bones; enable voluntary movement, posture, and locomotion.

Smooth muscles – found in internal organs (e.g., intestines, blood vessels); control involuntary movements like digestion and blood flow.

Cardiac muscle – found only in the heart; contracts rhythmically to pump blood throughout the body.

Tendons – tough connective tissues; attach muscles to bones and transmit force for movement.

Ligaments (support role) – connect bones at joints; help stabilize muscle action during movement.

Muscle fibers – individual muscle cells; contract and relax to produce movement.

Myofibrils – thread-like structures inside muscle fibers; responsible for contraction.

Actin – thin protein filament; works with myosin to cause muscle contraction.

Myosin – thick protein filament; pulls actin during contraction.

Sarcomere – functional unit of muscle contraction; shortens during contraction.

Neuromuscular junction – point where nerve meets muscle; transmits signals for contraction.

Motor neuron – nerve cell that stimulates muscle contraction.

ATP (Adenosine Triphosphate) – energy source for muscle contraction.

Muscle groups (e.g., biceps and triceps) – work in pairs; one contracts while the other relaxes to produce movement.

Biceps muscle – located in upper arm; bends the arm (flexion).

Triceps muscle – located in upper arm; straightens the arm (extension).

Diaphragm – dome-shaped muscle; controls breathing by contracting and relaxing.

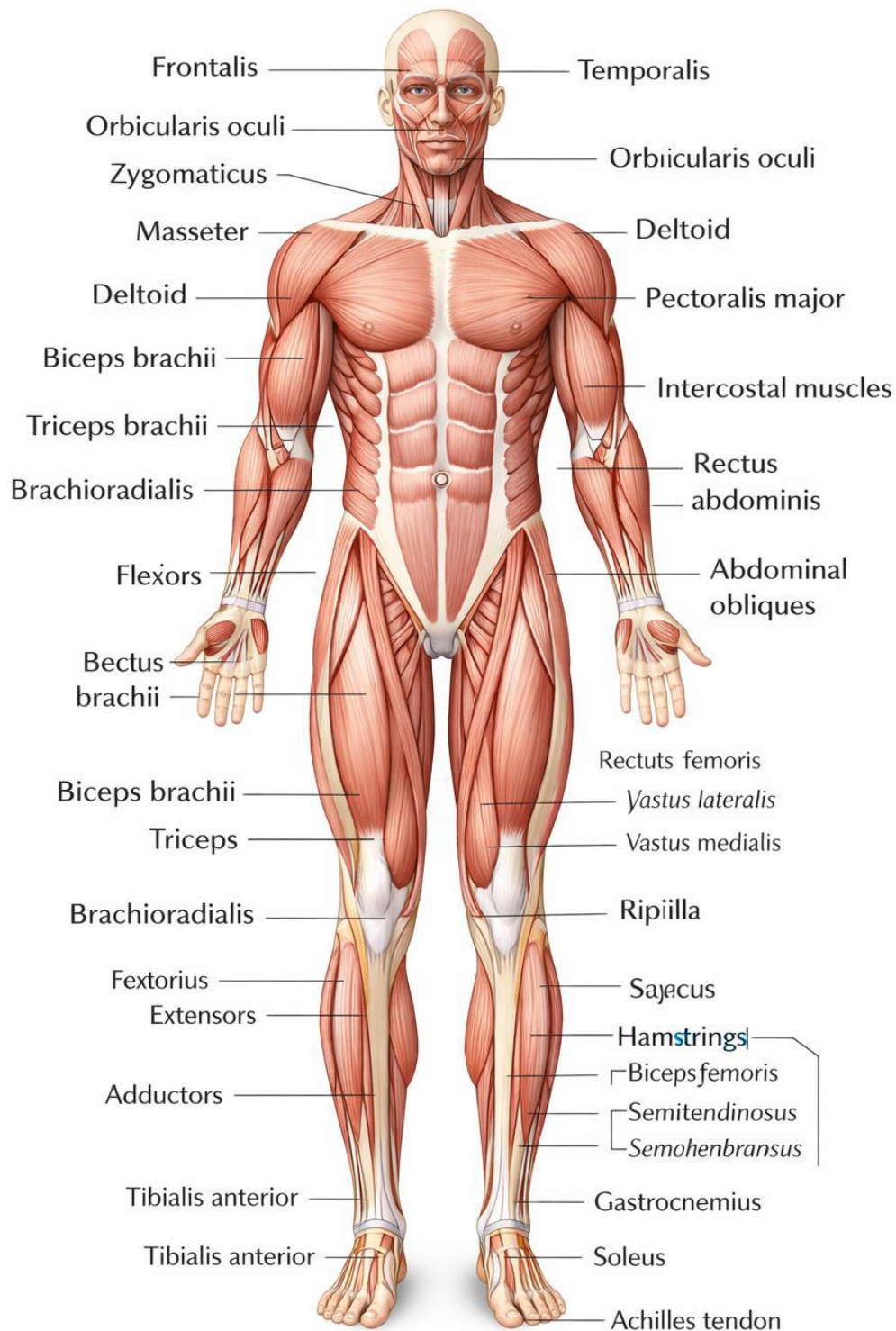
Intercostal muscles – muscles between ribs; assist in breathing.

Core Functions of the Muscular System

Movement of the body

Maintenance of posture

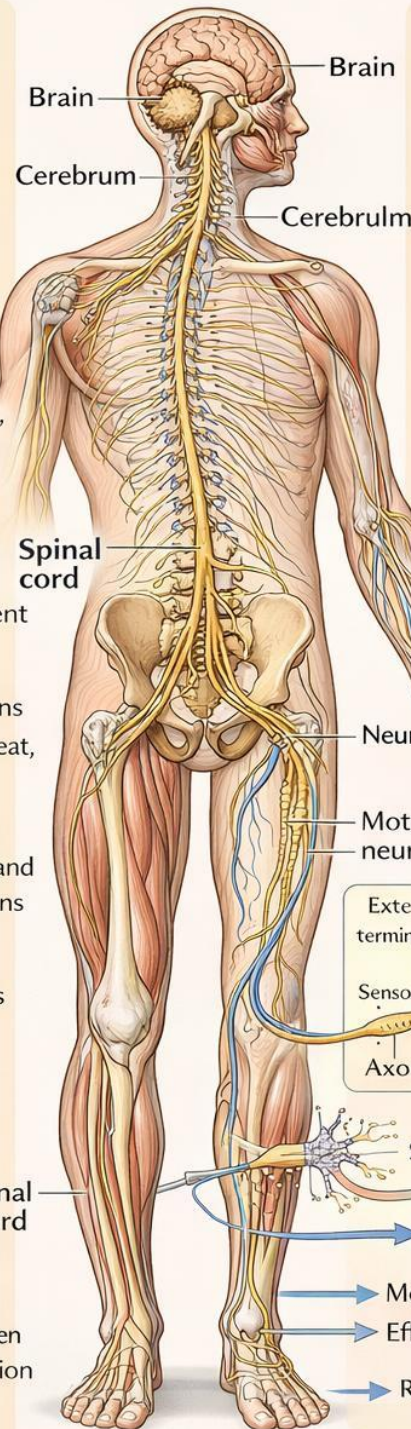
The Muscular System



The Nervous System

Key Parts and Their Functions

- **Brain** — control center of the body; coordinates activities, thinking, memory, and response
- **Cerebrum** — largest part of the brain; responsible for thinking, reasoning, memory, and voluntary actions
- **Cerebellum** — controls balance, posture, and coordination of movement
- **Medulla oblongata** — controls involuntary actions such as breathing, heartbeat, and digestion
- **Spinal cord** — transmits impulses between brain and body, controls reflex actions
- **Neuron** (nerve cell) — basic unit of the nervous system; transmits electrical impulses
- **Dendrites** — receive nerve impulses from other neurons
- **Axon** — carries impulses away from cell body
- **Synapse** — junction between neurons; allows transmission of signals
- **Neurotransmitters** — chemical substances; carry signals across synapses
- **PNS** — all nerves outside brain and spinal cord



Core Functions of the Nervous System

- Coordination and control of body activities
- Response to stimuli
- Transmission of nerve impulses
- Maintenance of balance and posture
- Control of voluntary and involuntary actions

Core Functions of the Nervous System

- Coordination and control of body activities
- Response to stimuli
- Transmission of nerve impulses
- Maintenance of balance and posture
- Reflex arc - pathway of a reflex action

Exam Trick (Very Important)



Exam Trick (Very Important)

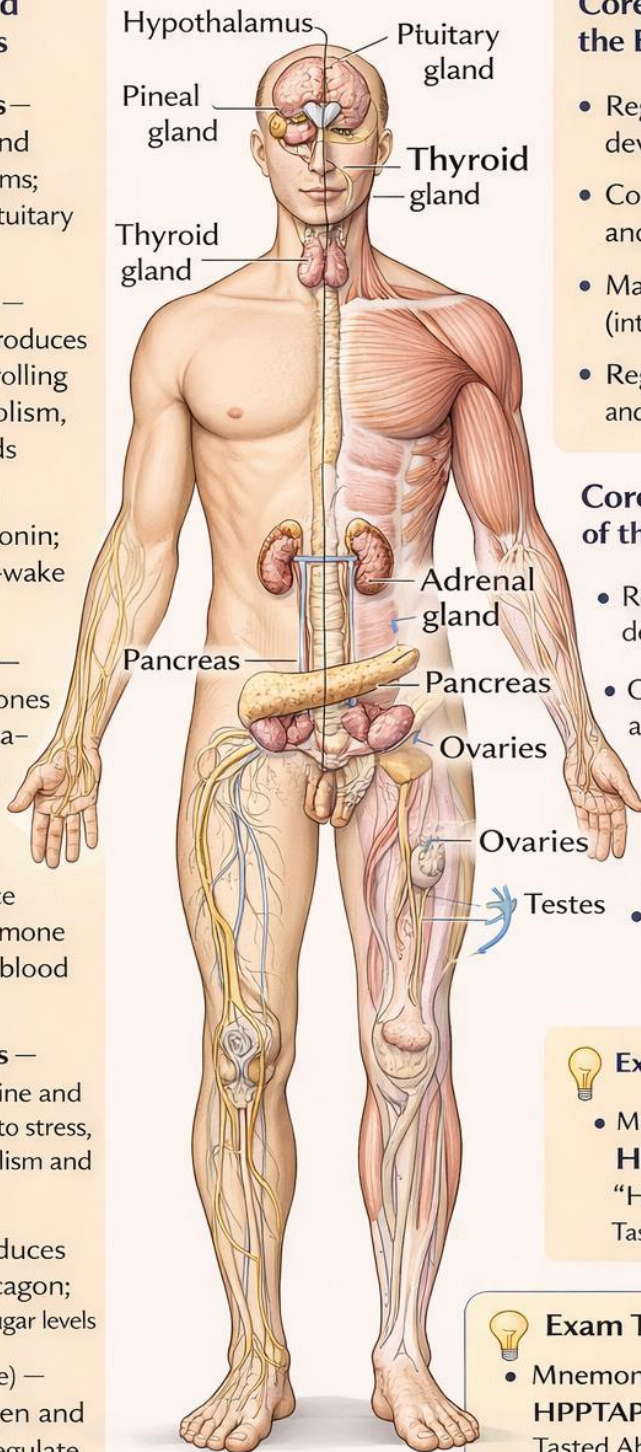
Outline the pathway of a reflex action:

Stimulus → **Receptor** → **Sensory Neuron** → **Cord**
Spinal Cord → **Motor Neuron** → **Effector** → **Response**

The Endocrine System

Key Glands and Their Functions

- **Hypothalamus** — links nervous and endocrine systems; regulates the pituitary gland
- **Pituitary gland** — master gland; produces hormones controlling growth, metabolism, and other glands
- **Pineal gland** — produces melatonin; regulates sleep-wake cycles
- **Thyroid gland** — produces hormones controlling metabolism, growth, and energy
- **Parathyroid glands** — produce parathyroid hormone (PTH), regulate blood calcium levels
- **Adrenal glands** — produce adrenaline and cortisol; respond to stress, regulate metabolism and blood pressure
- **Pancreas** — produces insulin and glucagon; regulates blood sugar levels
- **Ovaries** (female) — produce estrogen and progesterone, regulate menstrual cycle, pregnancy, and female secondary sexual characteristics
- **Testes** (male) — produce



Core Functions of the Endocrine System

- Regulates growth and development
- Controls metabolism and energy balance
- Maintains homeostasis (internal balance)
- Regulates reproduction and sexual development

Core Functions of the Endocrine System

- Regulates growth and development
- Controls metabolism and energy balance
- Maintains homeostasis (internal balance)
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Exam Tips

- Mnemonic for glands: **HPPTAP**
"Happy Pineapples Tasted Absolutely Perfect"



Exam Tips

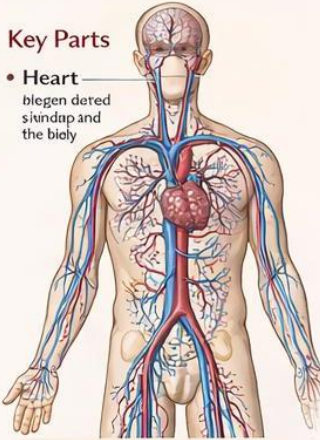
- Mnemonic for glands: **HPPTAP** "Happy Pineapples Tasted Absolutely Perfect"

Hormone: A chemical messenger released by a gland that travels through the blood to target organs

The Circulatory System

Key Parts

- **Heart** — begins deoxygenated blood and the body



Key Parts

- **Heart** — pumps blood throughout the body
- **Blood vessels** — tubes that carry blood (arteries, veins, capillaries)
- **Blood** — transports oxygen, nutrients, hormones, and waste products.

Exam Tips

- **RBCs:** Red Blood Cells — carry oxygen
- **WBCs:** White Blood Cells — fight infection
- Oxygen-rich — bright red
- Oxygen-poor — dark red

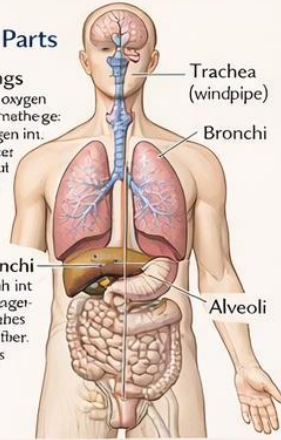
Exam Tips

- **RBCs:** Red Blood Cells — carry oxygen
- **WBCs:** white blood cells — fight infection
- Oxygen-poor — dark red

The Respiratory System

Key Parts

- **Lungs** — that oxygen gets exchanged (oxygen in, carbon dioxide out)
- **Bronchi** — bronchus that carries air into the lungs
- **Alveoli** — tiny air sacs in the lungs where gas exchange occurs



Functions of the Respiratory System

- **Lungs** — main organ for gas exchange (oxygen in, carbon dioxide out)
- **Trachea (windpipe)** — tube that carries air to the lungs
- **Bronchi** — tubes branching from the trachea into the lungs
- **Alveoli** — tiny air sacs in the lungs where gas exchange occurs

Exam Tips

- **Mnemonic for respiration:** "Please Leave The Breathing Alone"
 - Pharynx — Larynx
 - Trachea — Bronchi
 - Alveoli —

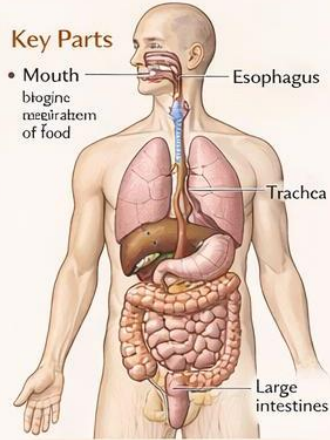
- **Diaphragm** — main muscle for breathing

- **Digestive system:** mechanical digestion (chewing; churning) vs. chemical digestion

The Digestive System

Key Parts

- **Mouth** — begins breakdown of food
- **Esophagus** — tube that carries food to stomach
- **Trachea** —
- **Large intestines** —



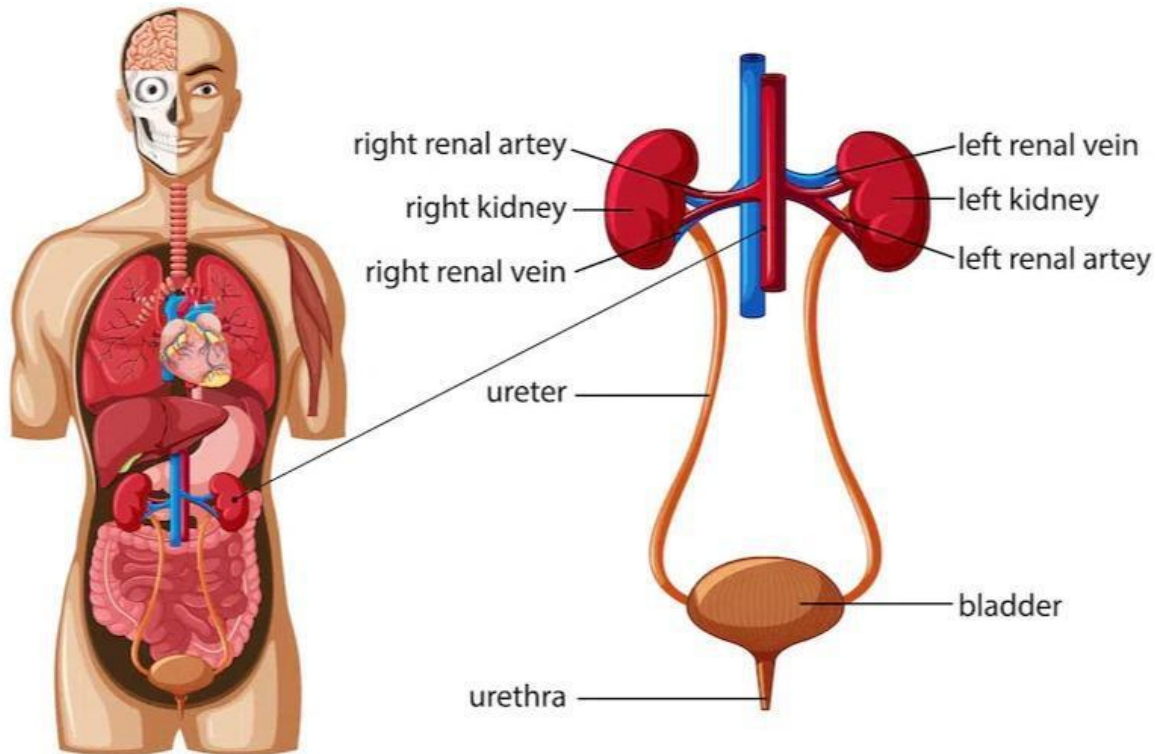
Functions of the Digestive System

- **Mouth** — begins breakdown of food
- **Esophagus** — tube that carries food to stomach
- **Stomach** — churns and breaks down food with acid and enzymes
- **Small intestines** — absorb nutrients from digested food
- **Large intestines** — absorb water from, and expel feces

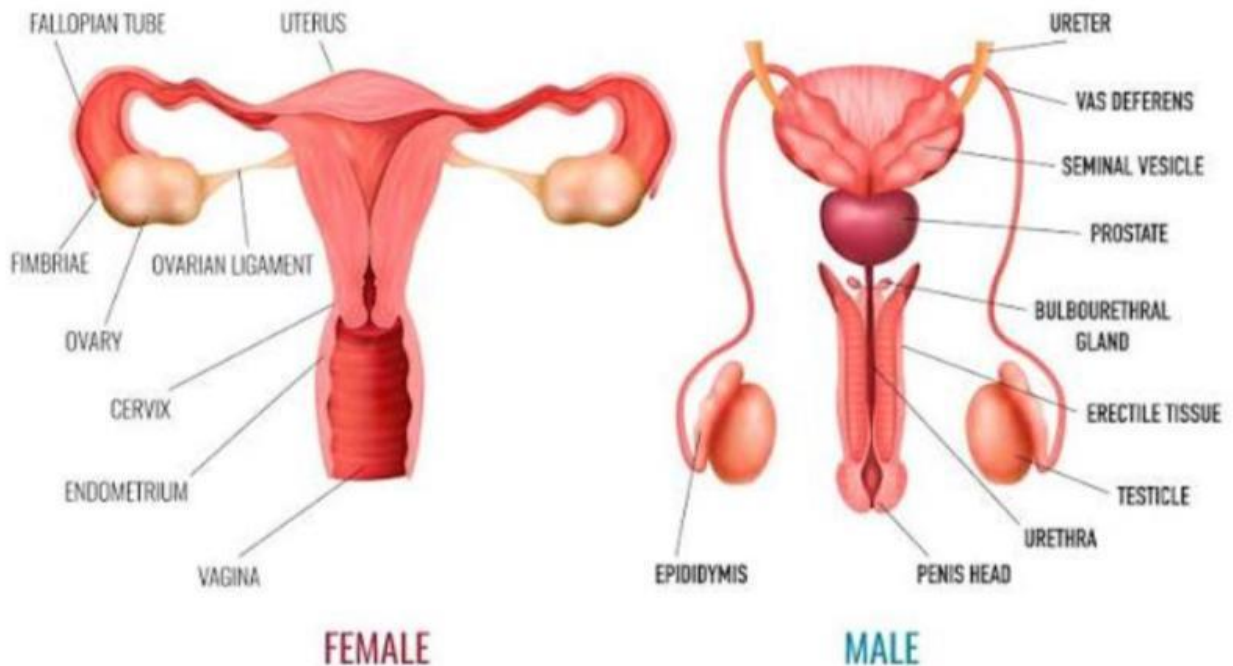
Exam Tips

- **Mnemonic digestion:** "My Esophagus Stops Small Little Restroom"
- **Digestive system:** mechanical digestion (chewing; churning) vs. chemical digestion (enzymes, acids)

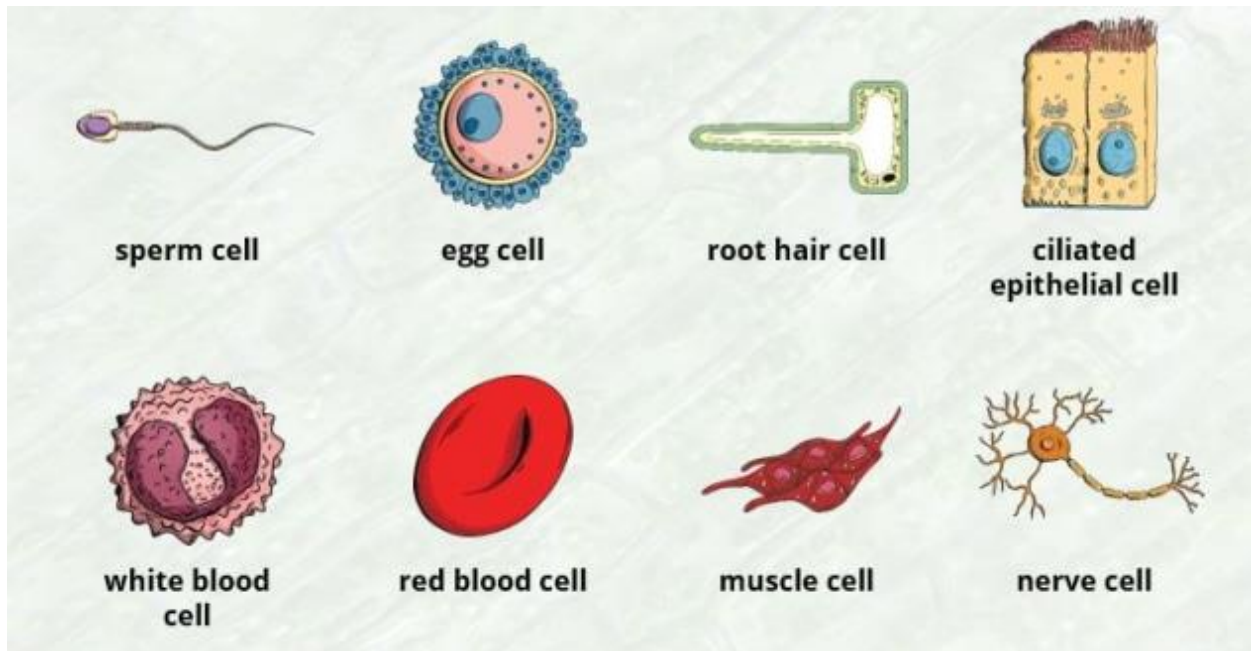
Human Excretory system



HUMAN REPRODUCTIVE SYSTEM



CELL TYPES AND THEIR IMAGES



ABOUT THE AUTHOR



Justice Osei Ofosu is a young researcher and a science student currently pursuing secondary education in General Science at Prempeh College in Kumasi. He is an author on Google Scholar with 2024 publications regarding land utilization and employee productivity. His research interests include general science, environmental sustainability, and software development.

JUSTICE PUBLICATIONS

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FEATURES

- ✓ Comprehensive formulae from all major topics
- ✓ Mnemonics and memory aids for quick recall
- ✓ Concept summaries for faster understanding.
- ✓ Well-structured for easy navigation
- ✓ Ideal for classroom, revision & exams.

